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(दूसरा पुनरीक्षण)

Indian Standard

RECOMMENDATIONS FOR PERFORMANCE RATING OF FUEL – FIRED FURNACES

(Second Revision)

ICS 25.180

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NEW DELHI 110002

May 2011 **Price Group 2**

Industrial Fuel-Fired Furnaces Sectional Committee, MTD 26

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Industrial Fuel-Fired Furnaces Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard was first published in 1979 and later revised in 1991. As a result of experience gained in implementation of this standard, it has been decided to revise this standard.

In an industrial fuel-fired furnace there are many performance parameters. Depending on the type, design and functional requirements of the furnace, some of the parameters are more relevant for assessing the suitability of the furnace for a particular use. Therefore, in assessing the performance rating, the aim should be to fix up technically correct and functionally appropriate performance parameters and to control their correctness by suitable tests. In this revision, supplementary information has been provided, for properly assessing the performance rating of furnaces.

This standard gives guidance for conducting ‘Acceptance Tests’ on a newly installed furnace for demonstrating satisfactory performance according to the agreement between the supplier and the user, and for conducting ‘Performance Tests’ by a furnace user to check its capability.

For the purpose of decided whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 ‘Rules for rounding off numerical values (*revised*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

RECOMMENDATIONS FOR PERFORMANCE RATING OF FUEL – FIRED FURNACES

(Second Revision)

1 SCOPE

This standard lays down the methods of describing and measuring the performance characteristics of fuel-fired industrial furnaces, using solid, liquid, gaseous or a combination of these fuels. This standard does not apply to electrical furnaces.

2 TERMINOLOGY

For the purpose of this standard, the following definitions shall apply.

2.1 Acceptance Tests — Tests carried out on a newly installed furnace for demonstrating satisfactory performance, according to the agreement between the user and the supplier of furnace.

Acceptance tests are generally aimed at checking or verifying the warranties or guaranteed performance parameters agreed upon in the contract and are to be carried out by the furnace supplier in presence of the user for the purpose of acceptance of the furnace by the user.

2.2 Performance Tests — Tests carried out by a furnace user to check its capability on the basis of performance data to be expected when the furnace is in operation.

3 SCHEDULE OF TEST

3.1 Acceptance Tests

In keeping with the purpose of the furnace, both the user and the supplier should agree to include, those primary performance parameters of the furnace as warranties/guarantees which have more technical and economic function. Acceptance tests should be conducted to establish or prove such primary performance parameters as warranted or guaranteed.

For the above, the following parameters are recommended.

3.1.1 *Throughput or Rated Output Capacity*

The quantity or effective product heated or treated per unit time, for which the following primary performance parameters should be specified in the contract:

a) Size, section or thickness of material and material specification; often a reference size/section and grade is agreed upon;
b) Percentage hearth coverage wherever applicable;
c) Temperature of material charged and discharged with acceptable tolerance limits for variation between the coldest and the hottest portion of the charge;
d) Heating conditions as well as heating cycles, if any; and
e) Any other item specific to the furnace.

3.1.1.1 Based on the specified and reference charge size (to be specified in the contract), the tests for acceptance of satisfactory performance with respect to throughput or rated output capacity of a furnace should fulfil or exceed the warranted or guaranteed values.

3.1.2 *Heat/Fuel Consumption*

The heat consumption is defined with respect to the specified throughput or rated output capacity (considered to be continuous output for a specified reference charge and for a given heating cycle or period). The heat/fuel consumption of a furnace should be indicated in terms of kcal/kg or Gcal/tonne of material charged into the furnace for a given throughput or rated output capacity. Fuel consumption for liquid fuels may also be specified in kg/tonne, for solid fuel in kg/tonne and for gaseous fuels in Nm^3/ tonne of material charged in the furnace at throughput or rated output capacity.

3.1.2.1 The consumption of auxiliary energy such as electric power, compressed air, steam used for atomising or heating of fuel and inert gases, etc, does not form a part of the heat consumption of a furnace.

3.1.2.2 The heat/fuel consumption is to be fixed for the exclusive process time of the charge in the furnace. This excludes secondary process time such as for heating up or keeping the furnace warm, charging and discharging time of batch furnaces, flushing or purging with inert gases before and after heat treatment etc. In case of hot charge, the heat/fuel consumption can be indicated as a guide and not as a guaranteed where charge temperature varies at the inlet of the furnace.

3.1.2.3 The following parameters should be mutually agreed and specified in the contract:

a) Reference dimensions.

b) Characteristics of fuel to be used (for example its calorific value, impurities, flash point, fire point, percentage moisture viscosity and other characteristics as appropriate).

c) Temperature of the material charged, important especially in case of hot charging of material in reheating furnaces.

d) Discharge temperature of material and the maximum operating temperature of the furnace with tolerance limits.

e) Heating conditions as well as heating cycle (time-temperature), if any.

f) Recommended furnace pressure with tolerance limits, including the points for pressure sensing inside the furnace.

g) Oxygen content of the furnace atmosphere at a defined location.

h) Scale losses wherever applicable.

j) Any other item particular to the furnace.

3.1.3 *Idling/No Load Consumption*

If due to any specific application problem or any other procedural difficulty the heat/fuel consumption of a furnace cannot be fixed accurately, then the idling/no load consumption in a furnace charged in batches can be guaranteed for a specific working temperature as the base load of heat/fuel consumption.

3.1.3.1 Idling/no load consumption covers the furnace's inherent losses at a given working temperature in a state of thermal balance. The following should be specified:

a) Rated working temperature of the furnace;

b) Climatic conditions external to the furnace (ambient air temperature, wind velocity, radiation from the neighbouring furnace, etc); and

c) Maximum permissible temperature on the smooth outer casing of the furnace away from burners, any other opening and flue ports, etc, located close by. [During acceptance test if the maximum permissible temperature on the smooth outer casing of the furnace atleast 1 m away from burner, any other opening and flue ports, etc. located close by (skin temperature) exceeds than the agreed value but the guranteed fuel consumption is maintained within the accepted limit, then this deviation may be accepted].

3.1.4 Unless otherwise agreed, the temperature variation (ΔT) inside the furnace shall be normally within ±10°C of the normal temperature to be achieved. [During acceptance test if the agreed ΔT (temperature uniformity) inside the furnace at the rated temperature exceeds the agreed value but the product (reference charge) is found conforming to the laid down specifications, then this deviation may be accepted by the customer]. However, for specific cases, the customer and the supplier may agree at a different value of the ΔT, inside the furnace.

3.1.5 For materials where the surface quality is of prime importance, the composition of the furnace atmosphere is to be specified and agreed upon. Mode of checking variation, etc, is to be mutually agreed.

3.2 Performance Tests

Tests carried out on the basis of secondary performance parameters should include the following:

3.2.1 Normal and maximum operating temperature of the furnace.

3.2.2 Flue gas temperature range leaving the furnace at the chimney base or at the entry of the recuperator if any.

3.2.3 Peak production rate and maximum fuel input in terms of kcal/h which the furnace is capable of giving.

3.2.4 In case any waste heat recovery equipment namely, regenerator/ recuperator/ waste heat boiler, is supplied with the furnace, the following information should be supplied:

a) Maximum and normal air/fuel gas flow, in Nm^3/h;

b) Flue gas temperature entering and leaving the equipment;

c) Momentary maximum permissible flue gas and air /fuel gas temperature;

d) Pressure drop on combustion air/fuel gas side and flue gas side, across the equipment; and

e) Steam evaporation, normal and peak, if waste heat boiler is involved, in kg/h.

3.2.5 Furnace working under externally prepared atmosphere gas (protective, reactive, inert) to be introduced into the furnace, the following information should be furnished:

a) Type of atmosphere (gas specification);

b) Maximum requirement of atmosphere gas, in Nm^3/h;

c) Allowable limits or concentration of undesirable components, if any;.

d) Capacity or output of the generator or facility in terms of basic (process) fuel requirement;

e) Method of heating, electricity/ fuel, etc; and

f) Utility requirements like fuel, power, water, etc.

3.2.6 Draught conditions on normal and peak operating conditions for furnace and chimney and/ or induced draft fan, if installed. Furnace should normally be designed for balanced draught, unless otherwise mentioned. The location of pressure tappings should be determined from case to case during testing of furnaces.

3.2.7 Outside surface or skin temperature of the furnace-casing or shell measured away from burners or any other openings and flue ports under steady normal operation should generally be within 60°C above ambient for furnaces operating above 1 000°C.

3.2.8 Rate of consumption of utility services, namely power, water, compressed air, steam, etc.

3.2.9 *Safety Devices*

All safety devices provided should be checked for reliability and fail-safe performance, by the supplier to the satisfaction of the customer.

4 MODE OF CONDUCTING THE TESTS

4.1 Responsibility for Conducting the Tests

Tests should be performed in the presence of accredited representatives of both the supplier and the user.

4.1.1 The test programme should be jointly drawn up and signed which should include the purpose and the scope of the experiments to be conducted, measurements to be taken and the measuring and regulating instruments/equipment to be used. As far as possible, the same instruments/equipment should be used in continuous operation and for conducting the tests.

4.1.2 It is recommended that an appropriate clause covering the cost of the agreed tests to be carried out is included in the contract.

4.2 Duration of Tests

Since acceptance tests are predominantly an exercise in continuous operation, the following points should be considered while fixing the programme or schedule for the tests.

4.2.1 Acceptance tests should generally be conducted within an agreed specified period of the furnace attaining normal operating temperature. Acceptance tests should not be carried out on the first day, following a full rest day or holiday. The date should be fixed according to the design and operating procedure of the furnace as recommended by the manufacturers.

4.2.2 The period of test in a batch operating furnace must be distinctly longer than the time of stay of the product in a furnace.

4.2.2.1 In a continuously operating furnace, the duration of tests should not be less than the time of stay of the product in the furnace. Test is to be conducted after the furnace has attained a steady stabilized condition.The duration of the test shall be minimum 8 h.

4.2.2.2 In an intermittently operating plant the test duration should not be less than 8 h. Results should be based on an average of at least three cycles.

4.2.2.3 In batch type heat treatment furnaces the test may be limited to one complete cycle of heat treatment. For batch furnaces, the same thermal state should be maintained at the start and end of the tests.

4.2.3 Depending upon the type of furnace and its nature of operation, a pre-test stabilisation period should be allowed and agreed upon which should however, not form part of the test. The pre-test phase should as far as possible maintain the conditions identical to those required for actual test period or phase.

4.2.3.1 This procedure is more important for intermittently operating furnaces.

4.2.4 Post-test shall also be held under the conditions identical to those required for actual test period or phase. Post-test period shall be mutually agreed upon by user and supplier. Post-test, though not forming a part of the test, will demonstrate the consistency of the furnace performance. But there will be no contractual obligation.

4.3 Test Procedure

4.3.1 Proper records should be kept during the entire test period entering various readings taken at brief intervals, for example at every 15 min on indicating instruments and at longer interval, say at 30 min. using recording instrument. All charts/curves plotted from the measurement should be attached to the test report. All such readings and documents should be approved by the contracting parties.

4.4 Measuring Methods

4.4.1 *Time and Date*

The charging and discharging time and date for continuously operating furnaces to ascertain the period of stay of the product in the furnace are to be recorded.

For heat treatment furnaces, separate note should be kept of heating, soaking and cooling, if any, indicating the time temperature relation during the entire cycle.

4.4.2 *Materials Charged in the Furnace*

Number of pieces, full particulars or specification of the material and weight charged should be recorded in order to determine the throughput capacity which is the effective amount of charge heated or treated per unit time.

4.4.3 *Temperature Measurement*

It is generally called for when proper assessment of the heating condition of the charge/product is considered important and agreed upon in the contract. Recommendations for measuring instruments are given below:

Temperature Measurement	*Measuring Method*
a) On surface of the product (with or without scale/film):	
1) Inside furnace 2) Outside furnace	Optical or Thermoelectric
b) Inside the product within the furnace (for drilled work piece with inserted thermocouple)	Thermoelectric
c) Inside the furnace chamber at representative locations	Thermoelectric

4.4.4 *Fuel Properties: Calorific Value*

4.4.4.1 *Liquid fuels*

It should be determined by a bomb calorimeter by a competent authority to be mutually agreed upon. Representative samples should be collected.

4.4.4.2 *Gaseous fuels*

It should be determined preferably by Junker's calorimeter at a representative spot or by calculation from the analysis of the gas to be obtained from a competent authority. The. average of a number of values/readings spread over the duration should be taken.

4.4.5 *Fuel/Heat Input/Consumption*

4.4.5.1 *For liquid and gas fuels*

a) By calibrated flow meters as per the standard laid down, and

b) Meter with integrator should be calibrated before and after the test. If recording chart is provided in place of integrator, it should be measured by a plan meter to obtain the total consumption over the specified period.

5 ANALYSIS OF TESTS

5.1 Correctness of all the measured values should be checked and mutually approved.

5.2 Allowable errors in the measured values should also be agreed upon and approved mutually.

6 TEST REPORT

A test report should be submitted by the representative/representatives responsible for conducting the test. This should generally include the following:

a) Object of the test;

b) Mode of conducting the test;

c) Specification of the furnace with guaranteed/indicated performance;

d) Test results;

e) Conclusion;

f) Satisfactory functioning of safety devices; and

g) Annexes — Log sheets, details of materials charged, fuel analysis and test reports, etc.

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This Indian Standard has been developed from Doc No. : MTD 26 (4729).

Amendments Issued Since Publication

Amendment No.	Date of Issue	Text Affected

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